

pecuniary results, though more accordant with ordinary experience. Let the reader of these eight chapters on "Farming for Pleasure and Profit" omit everything except what is given on the personal authority of the author, and he will gain a number of useful hints showing how to economise the vegetable food raised on a small farm, and to make amateur agriculture in some ways less financially disastrous than is usually the case. But we shall not find a complete system of practice here; nor do we discover any hints, however remote, of the chemical composition and physiological functions of food; and we look, too, in vain for any recognition of recent advances in our scientific knowledge as to methods of manuring and cropping.

LETTERS TO THE EDITOR

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.*]

[*The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.*]

Theory and Laws of the Microphone

Two hypotheses have been projected to explain the action of the microphone. One is molecular exclusively, and supposes that the molecules of certain conducting bodies contract and dilate under sonorous vibrations. Changes of density correspond with an increase or diminution of the resistance of the circuit. This hypothesis renders the phenomena analogous to those which selenium presents under the influence of light and radiant heat. The other explanation, partly mechanical and partly molecular, is the result of a discovery made some time since by M. du Moncel, according to whom the increase or diminution in resistance is due to changes of pressure at the points of electric contact. These changes of pressure are effected by the vibration of the air; hence the cause and the effect are similar.

As the result of numerous experiments, I shall endeavour to prove that, while one of these theories is altogether erroneous, the other is only superficially true.

1. If the piece of charcoal is fixed with wax without any pressure, the microphone remains silent under the strongest sonorous impulses, which would be impossible were the movement molecular.

2. The microphone may be inclosed in a vacuum chamber without altering the result; in this case waves of air can have no effect upon the density of the charcoal.

3. It is impossible to construct a microphone from one solid piece of charcoal, presenting stable contact, such as would not interfere with molecular action, but which prevents the sonorous waves from affecting the currents which traverse the carbon.

These afford sufficient reasons for rejecting any simply molecular theory.

Now against the second theory.

1. Lateral pressure on a compact electric conductor excites no microphonic action.

2. Longitudinal pressure within certain limits on the charcoal does not injure the apparatus.

3. An apparatus can be made to yield microphonic effects where there is no alteration of pressure. Pressure, therefore, is no essential cause of microphonic sounds, though it may be an accidental one.

In all microphones where contact is made at one point only, the current is interrupted whenever this point of contact is broken; a musical sound is heard when the two points are in vibration. This microphone, like Reis's telephone, can only transmit musical sounds. I have obtained the best results from a steel point and a membrane of a stretched bladder. A strip of tin-foil is gummed to the membrane to insure electric contact. With a single small cell of bichromate of potash a song can be heard through a whole room.

To transmit articulate sound it is necessary that the number of points of contact, the difference in this number during action, and the resultant changes of resistance, should be greater. The interruption of the current is then only partial; it becomes

"undulatory." To this description belong the principal microphone of Mr. Hughes, Edison's carbon telephone, the transmitting telephone of two graphite pencils of MM. Pollard and Garnier, Hellenen, &c.

A convenient form of microphone, which transmits words, music, the noise of a watch, &c., has the membrane of india-rubber stretched tight by a thin strip of tin-foil which unites the carbon underneath with the screw. The vibrations of the membrane throw a greater or less number of points into contact; all the shades of expression in the voice may be transmitted, owing to the rapidity of these small changes. It is the changes in the points of contact which here play the chief part, and there is little doubt that here we have the quality as well as the intensity of a sound reproduced.

This explains many of the microphonic actions, but not all. Here is one case:—

If the microphone is formed of two cylindrical pieces of charcoal, the points of contact cannot be made to vary by pressure, supposing the cylindrical shape to be perfect. The action here is due to the distance the current has to traverse the bad conductor; for the membrane to which these charcoal points are attached approaches or recedes from them when vibrating. The liquid telephone transmitters of Bell, Gray, and Salet rest upon the same principle where a change of resistance in the circuit is due to the varying depth of liquid traversed by the current. This, equally with the theory of the points of contact, explains the microphone of M. Righi, where a metallic disk is plunged into a powder of lead and silver mixed.

The next class of instruments consists of those where the current is created, and varies under the influence of microphonic electrodes (by this I mean the opposite parts of a microphone, whether in direct or indirect contact). Such are microphonic batteries. Each battery can act as a microphone if one of its poles is movable. Two ends of iron wire, dipped in ordinary water, and brought together, give signs of microphonic action. One pole is attached to the vibrating membrane, and dips at its extremity into the liquid, while the other pole remains there constantly. The current only passes when the movable pole is in the liquid. On singing into the tube the vibrations of the membrane cause the pole, which is also a microphonic electrode, to dip into the liquid, setting up chemical action as many times a second as there are vibrations in the note sung. If the pole touches the liquid constantly, the current is constant, but varies in intensity for four reasons: the different number of points exposed to electrolytic action; the different number of points of electric contact; the different number of the points of resistance of the liquid; and the different number of the points of approach of one pole to the other; all these are due to the movement of one of the microphonic electrodes.

There is yet another class of microphones. In all the instruments hitherto constructed, the direction of the current remains the same, but it is possible to make it change, thus introducing another difference in the manner of its action.

In all the possible forms of microphone, the chief causes of the action are:—a mechanical movement of its parts, a change in the points of conductivity, a change of resistance; these three essentials result from one another. The expression "points of conductivity" includes not only the points of contact, but also the route taken by the current.

The next point of consideration is the so-called increase of sound by a microphone, but this is not the case. All sounds are weakened by the microphone, and are transmitted only when the source of sound is in direct contact with the microphone or its stand. The microphone is less an instrument for transmitting sound than for transforming mechanical movement into sound. The intensity of a sound is, therefore, directly proportional to the energy of the mechanical movement accompanying the sonorous waves, or as a necessary consequence to the changes of resistance in the microphone. The distinctness of articulate sounds, transmitted by the microphone, is in inverse proportion to their intensity; for a loud sound tends to interrupt completely the current, and thus to prevent the transmission of articulate sounds. This is the chief hindrance to increasing, at pleasure, the loudness of the sound. The loudness of the sound is also dependent on the strength of the current.

Other experiments prove that the rapidity of movement of the parts of a microphone also affects very considerably the resultant sound, as well with a strong, as with a feeble current. Changes in resistance and in current strength are not sufficient, unless made rapidly, to excite microphonic action.

Great as is the invention of Mr. Hughes, the microphone reveals no new property of matter, neither does it show the direct effect of sonorous waves upon partially conducting bodies.
Lemberg University JULIAN OCHOROWICZ

"The Rights of an Animal"

I AM sorry that my review appears to have caused Mr. Nicholson some annoyance, but am not surprised that in his rejoinder he has not attempted to meet any one of my criticisms. As he now expressly avoids the well-known ambiguity which attaches to the word "same," he clearly avows his meaning to be what in my review I supposed it could not be, viz., that animals have "in all respects *identical* rights of life and liberty with man." If this proposition is seriously stated, it does not require a "writer capable of reviewing an ethical essay" to see that it cannot possibly have a place in any such essay, properly so called. And in supposing that this could not be the fundamental proposition which Mr. Nicholson intended to maintain, I did not "forget" that the animals which he allows "to be killed or worked were only allowed to come into life for these purposes." For if the rights of animals are *identical* with those of men, and if the breeding of animals for the purpose of killing them morally justifies the butcher in taking their lives, it certainly follows, for instance, that a physiologist would be morally justified in vivisectioning his own children on the plea that it was for this purpose that he had begotten them. Where such is the necessary ethical conclusion, it is clear that the ethical premises by which it is evolved must be erroneous.

As regard the crustaceans, seeing that they are not "harmful animals," I chose them as a type of the class of animals which Mr. Nicholson plainly says it is in his opinion morally wrong to kill.

I may add that I omitted to mention the "plea" to which his letter in NATURE refers, because it had no relation to the opinion I was criticising—the opinion, namely, that harmless animals ought not to be killed for food. Here, however, is the "plea." "It may be answered that if none of these (*i.e.*, crustaceans) were killed more land animals would be killed for food; that their death allows more land animals to be kept alive for other purposes; and that this sharing of risks is only fair to the latter, the more so as they stand higher in point of intelligence and usefulness. Is this plea sound?" I can scarcely suppose that Mr. Nicholson will thank me even now for reproducing so feeble an argument, and in any case am quite sure that the latter, whatever it is worth, has no reference to the abstract principle which I was examining.

The relevancy of Mr. Nicholson's "protest" I fail to perceive. That "principle" and "self-interest" are not synonymous is sufficiently obvious, but I do not see how this consideration affects my charge of "inconsistency of principle." I simply pointed out that if we have a moral right to slay a harmful animal in order to better our own condition, it involves an inconsistency of principle to deny that we have a similar right to slay a harmless animal, if by so doing we can secure a similar end. And this obvious criticism is not affected by the irrelevant remark that "principle" and "self-interest" are not synonymous.

Again, as I was reviewing Mr. Nicholson's essay, and not Mr. Lawrence's book, I deemed it unnecessary to allude to the "reprints" from the latter, more especially as I saw nothing in these reprints of a nature either "interesting" or instructive. If my omission in this respect is calculated to damage the sale of the essay which I reviewed, I can only express my sorrow that such should be the case; but as I further omitted to state that the pages of the essay are small and very widely leaved, the idea which I conveyed of the size of the book as a whole was certainly not an inaccurate one.

I have taken the trouble to reply to the above remonstrance thus fully because I am conscious of having done what every honest reviewer ought to do, viz., to state what he thinks and to give his reasons for what he states. But as the result in this case has been to dissatisfy the author reviewed, I think it is now desirable to prove, by subscribing my name, that I have no personal *animus* against him.

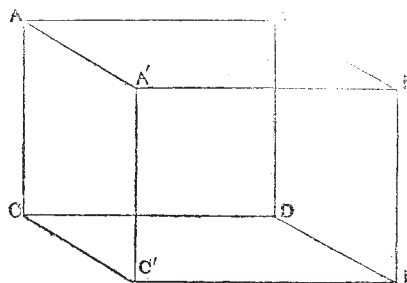
GEORGE J. ROMANES

A Suggestion on the Action of the Oblique Muscles of the Eye-ball

THE action of the so-called oblique muscles of the eye-ball has been a *questio vexata* amongst anatomists for a long time,

but I, in all submission, venture to suggest the following experiment which *may* be entertained mathematically. I speak of my own eyes, and the method in which I endeavour to use my oblique muscles, according to authorities.

Suppose I draw a skeleton cube at haphazard thus—



and I *concentrate* my vision on the anterior plane of this cube ($A'B'C'D'$) in the sketch; if I put in action (according to what we believe to be the action) the superior and inferior oblique muscles, the projection is immediately altered, and the plane $A'B'C'D'$ is instantly the anterior? Pardon my apparent ignorance of physics, but may not some of your many correspondents, without ignoring my anatomical knowledge, make the statement a basis for research. A good explanation for the condition I must confess has escaped me?

It may throw some light on the question as to whether the oblique muscles definitely alter the optical functions of the eye, which is certainly a matter of the greatest practical interest.

EDWARD BELLAMY

Natural History Notes from Burmah

1. *The Dorian*.—The Dorian is a large capsular fruit with four or five loculamenta, each containing one seed which is covered with a layer of pulp, the part eaten. The rind, as well as the seeds, emits a strong odour of sulphide of methyl.

Dorian eaters say that the excellency of the fruit consists in the succession of exquisite flavours experienced in eating it. From my own experiments I believe this to be due to a reaction of the nerves of taste, analogous to that of the retina, which causes the images of objects to appear in their complementary colours when the eye is suddenly shut.

2. It is asserted that the weaver bird has the habit of fixing fire-flies to the side of its nest by means of a lump of mud, for the purpose of illuminating its nest at night. I have not observed it myself. Perhaps some of your readers may have seen or heard of the practice.

3. *Ants*.—There is here a species of small black ant, of which there occur gigantic specimens differing from the others only in size. They seem to act as the elephants of the community, carrying loads that the small ones cannot lift. Sometimes one of these "elephants" may be seen returning to the nest with several of the ordinary size clinging on its back.

Once while taking lunch in the image cave at Maulmain, we observed several large black ants wandering about. A chicken bone thrown in their path was soon discovered, and a messenger was despatched to the nest, from which a compact body of ants soon issued. But by some mistake they took the wrong direction from the nest, and proceeded towards a fragment of plaster that had fallen from one of the statues and lay on the floor of the cave. This they examined all over, and then returned to the nest in a less orderly manner than they had marched out, but at the entrance some other ants met them, who must somehow have given them the proper direction, for they at once changed their course towards the bone, which was soon covered with ants. I think this observation has some bearing on the way in which ants communicate. It is clear that the messenger's signs were misunderstood, and they went so straight to the bit of plaster that it appeared to me that they must have seen it, for sight is the only sense that could have been deceived. The distance was about four feet, and this occurred near the entrance to the cave, so there was light enough if their range of vision was great enough.

R. ROMANES

Government High School, Rangoon